

Improved CVD Coatings for NTP Fuel Elements, Phase I

Completed Technology Project (2007 - 2007)



Project Introduction

One of the great hurdles to further development and evaluation of nuclear thermal propulsion systems is the issue surrounding the release of radioactive material from the fuel during ground testing and its subsequent impact on test facility siting and operation. Therefore, the development of a crack resistant coating system on fuel elements nuclear thermal propulsion that is insensitive to hydrogen corrosion and erosion is considered enabling. Ceramic Composites Inc. (CCI) proposes a systematic approach for CVD deposition and evaluation of a family of zirconium carbide (ZrC) and niobium carbide (NbC) coating systems for both uranium carbide-zirconium carbide solid solution [(U,Zr)C]-graphite composite fuel elements and advanced triple carbide (uranium carbide-zirconium carbide-niobium carbide) solid fuel elements designed for use in space nuclear power and propulsion reactors. These refractory metal coating systems will be evaluated in high temperature hydrogen in concert with a preliminary performance modeling effort.

Anticipated Benefits

The development of a high quality coating for space nuclear reactor fuel elements could have potential across a variety of nuclear applications. A variety of designs exist for the next generation nuclear power plant, such as the Gas Cooled Fast Reactor (GCFR) and the Very High Temperature Reactor (VHTR). In the case of both of these the final fuel form has not been decided. The triso fuel particle has been suggested for both as well as clad solid fuel pins. Either of these two fuel forms could benefit from an improved fuel coating of this type. The idea of using mixed carbides (U,Zr)C, (U,Nb)C, which would allow for much higher operating temperatures, for both pellets and solid fuel pins has been put forth and both would require a cladding material. Most of these systems will operate above the temperature limit of SiC or would have compatibility issues with the standard C/C/SiC/C (triso) coating developed for pebble type fuel. The case of the VHTR the reactor has the ability to generate hydrogen by splitting water molecules, the presence of hydrogen and oxygen pose serious problems for the triso coating. The development of a high quality coating for space nuclear reactors will be enabling for the development of nuclear thermal propulsion (NTP), in particular if one uses fuel elements based on the Rover/NERVA heritage design or the Pebble Bed design. The higher specific impulses afforded by NTP will provide significantly shorter travel times to the moon and Mars, reducing the time in zero gravity for manned missions and greatly increasing the speed of cargo/supply deliveries and unmanned exploration missions.



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Table of Contents

| | |
|--|---|
| Project Introduction | 1 |
| Anticipated Benefits | 1 |
| Organizational Responsibility | 1 |
| Primary U.S. Work Locations and Key Partners | 2 |
| Project Management | 2 |
| Technology Areas | 2 |

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Glenn Research Center (GRC)

Responsible Program:

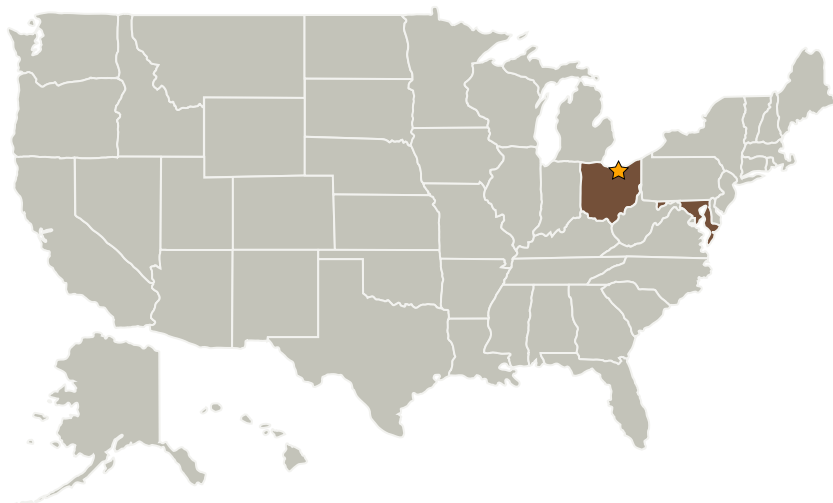
Small Business Innovation Research/Small Business Tech Transfer

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Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|-------------------------------|-------------------------|-------------|---------------------|
| ★ Glenn Research Center(GRC) | Lead Organization | NASA Center | Cleveland, Ohio |
| Ceramic Composites, Inc. | Supporting Organization | Industry | Annapolis, Maryland |

Primary U.S. Work Locations

| | |
|----------|------|
| Maryland | Ohio |
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Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Bryan A Palaszewski

Principal Investigator:

Steven Seghi

Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.4 Advanced Propulsion
 - └ TX01.4.3 Nuclear Thermal Propulsion